TITLE: METHODS FOR SOLVING THE TRAVELING SALESMAN PROBLEM DOCKET NO.: 256.098US1

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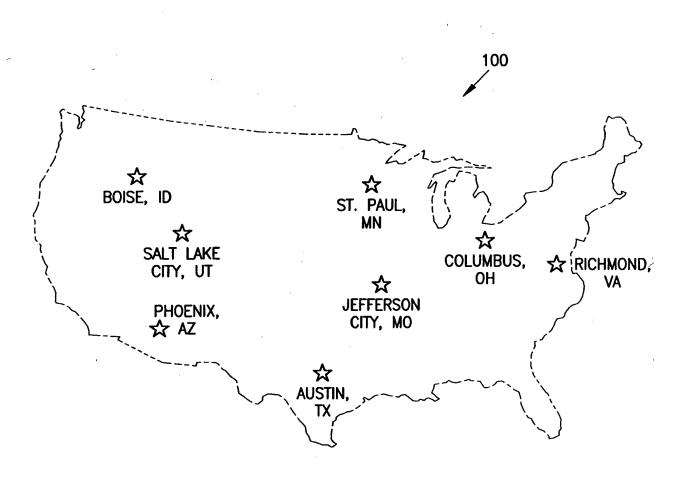


FIG. 1

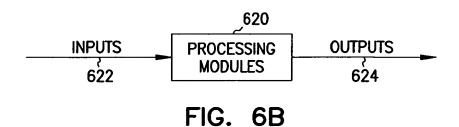
FIG. 3

FIG. 5

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INVENTORS NAME: Ravindra K. Shetty DOCKET NO.: 256.098US1





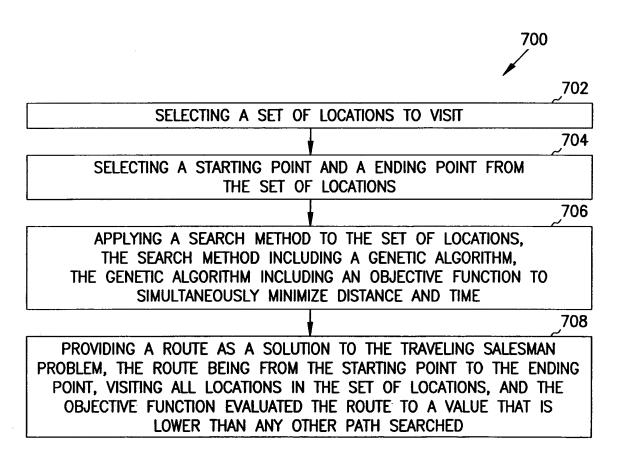


FIG. 7

m

704 SELECTING A STARTING POINT AND A ENDING POINT FROM 706 APPLYING A SEARCH METHOD TO THE SET OF LOCATIONS. THE SEARCH METHOD TO COMBINE SIMULATED ANNEALING AND A GENETIC ALGORITHM. THE GENETIC ALGORITHM INCLUDING AN OBJECTIVE FUNCTION TO 802 WHEREIN THE GENETIC ALGORITHM GENERATES POPULATIONS OF SIZE 2K. WHERE THE SET OF LOCATIONS IS OF SIZE K 804 WHEREIN THE GENETIC ALGORITHM COMPRISES: A SELECTION OPERATION, A CROSSOVER OPERATION, AND A MUTATION OPERATION 806 WHEREIN THE SELECTION OPERATION IS CHC SELECTION 808 WHEREIN THE CROSSOVER OPERATION IS GREEDY CROSSOVER 810 WHEREIN THE CROSSOVER OPERATION HAS A CROSSOVER PROBABILITY BETWEEN ABOUT 0.6 AND 0.9 812 WHEREIN THE MUTATION OPERATION COMPRISES SWAPPING TWO LOCATIONS AT TWO RANDOM POSITIONS IN A CHROMOSOME ,814 WHEREIN THE MUTATION OPERATION HAS A MUTATION PROBABILITY BETWEEN ABOUT 0.001 AND 0.01 816 WHEREIN THE GENETIC ALGORITHM FURTHER COMPRISES: ENCODING LOCATIONS INTO CHROMOSOMES, THE CHROMOSOME HAVING THE SAME NUMBER OF POSITIONS AS K, THE LOCATIONS BEING REPRESENTED IN EACH POSITION BY AN INTEGER 708 PROVIDING A ROUTE AS A SOLUTION TO THE TRAVELING SALESMAN

TITLE: METHODS FOR SOLVING THE TRAVELING SALESMAN PROBLEM

702

800

PROBLEM. THE ROUTE BEING FROM THE STARTING POINT TO THE ENDING POINT, VISITING ALL LOCATIONS IN THE SET OF LOCATIONS, AND THE OBJECTIVE FUNCTION EVALUATED THE ROUTE TO A VALUE THAT IS LOWER THAN ANY OTHER PATH SEARCHED

ITLE: MEINODS FOR SOLVING THE TRAVELING SALESMAN PROBLEM

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FIG. 10

COMPARED WITH ALL OTHER PICKUP PATHS SEARCHED

<u>I</u>T

CARCOTTON

TITLE: METHODS FOR SOLVING THE TRAVELING SALESMAN PROBLEM INVENTORS NAME: Ravindra K. Shetty DOCKET NO.: 256.098US1 8/18 1100 902 ACCESSING A SET OF ORDERS 904 SELECTING A SET OF SUPPLIER LOCATIONS TO VISIT TO PICK UP PRODUCTS TO FILL THE SET OF ORDERS 1102 COMPUTING A DISTANCE BETWEEN EACH SUPPLIER LOCATION IN THE SET OF SUPPLIER LOCATIONS 1104 WHEREIN THE SET OF SUPPLIER LOCATIONS INCLUDES A DISTRIBUTION CENTER 1106 ELIMINATING REDUNDANCIES IN THE SET OF SUPPLIER LOCATIONS BY SELECTING A FIRST SUPPLIER OVER A SECOND SUPPLIER, WHEN THE FIRST SUPPLIER'S AVAILABLE PRODUCTS AND SECOND SUPPLIER'S AVAILABLE PRODUCTS ARE THE SAME, BUT THE FIRST SUPPLIERS HAS MORE AVAILABLE PRODUCTS TO FILL THE ORDERS THAN THE SECOND SUPPLIER 906 SEARCHING FOR PICKUP PATHS VISITING EACH SUPPLIER LOCATION IN THE SET OF SUPPLIER LOCATIONS, BY APPLYING A GENETIC ALGORITHM THAT SIMULTANEOUSLY MINIMIZES DISTANCE AND TIME 1108 SEARCHING FOR PICKUP PATHS ENDING AT THE DISTRIBUTION CENTER 908

PROVIDING A PICKUP ROUTE WHICH COMPRISES A PICKUP PATH
THAT BEST SIMULTANEOUSLY MINIMIZES DISTANCE AND TIME
COMPARED WITH ALL OTHER PICKUP PATHS SEARCHED

WHEREIN THE PICKUP ROUTE ENDS AT THE DISTRIBUTION CENTER

1110

(11B)

**FIG. 11A** 

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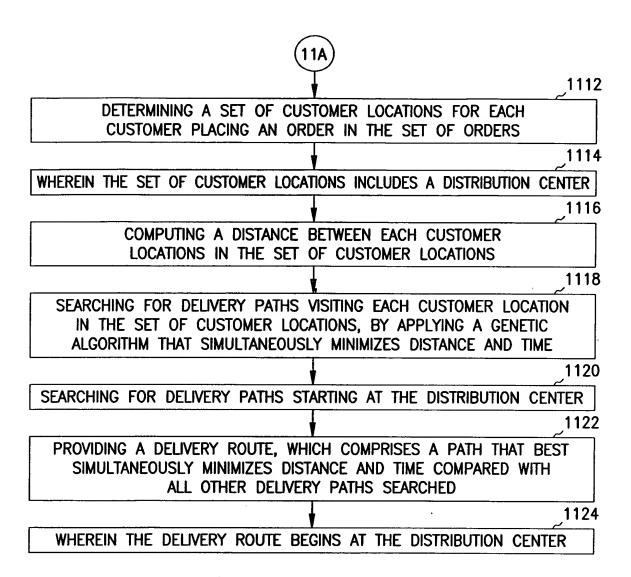


FIG. 11B

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1200

1202

RANDOMLY GENERATING AN INITIAL POPULATION OF CHROMOSOMES TO BE A CURRENT POPULATION, EACH CHROMOSOME HOLDING A PREDETERMINED NUMBER OF INTEGERS WITH ONE INTEGER AT EACH POSITION IN THE CHROMOSOME, EACH INTEGER REPRESENTING ONE LOCATION OF A SET OF LOCATIONS

1204

CALCULATING A FITNESS FOR EACH CHROMOSOME IN THE CURRENT POPULATION, THE FITNESS MEASURING DISTANCE AND TIME SIMULTANEOUSLY

1206

SELECTING ONE OR MORE PAIRS OF PARENT CHROMOSOMES FROM THE CURRENT POPULATION BASED ON THEIR FITNESS TO GENERATE THE NEW POPULATION

1208

CROSSING OVER THE PAIRS AT A RANDOMLY CHOSEN POINT, WITH CROSSOVER PROBABILITY  $P_{\rm C}$  BETWEEN ABOUT 0.6 AND 0.9, TO FORM OFFSPRING TO GENERATE THE NEW POPULATION

1210

MUTATING THE OFFSPRING AT EACH POSITION ON THEIR CHROMOSOMES, WITH MUTATION PROBABILITY  $P_m$  BETWEEN ABOUT 0.001 AND 0.01, TO MODIFY THE NEW POPULATION

1212

MAKING THE CURRENT POPULATION A PREVIOUS POPULATION AND REPLACING THE CURRENT POPULATION WITH THE NEW POPULATION

1214

FORMING NEW GENERATIONS BY REPEATING THE CALCULATING, SELECTING, CROSSING OVER, MUTATING, AND MAKING ACTS, UNTIL A PREVIOUS BEST FITNESS IN THE PREVIOUS POPULATION IS THE SAME AS A CURRENT BEST FITNESS IN THE CURRENT POPULATION

1216

PROVIDING A PATH REPRESENTED BY A CHROMOSOME HAVING A BEST FITNESS IN THE CURRENT POPULATION

FIG. 12

TYTEE 17

TL

m

FIG. 13A

IN THE OFFSPRING INSTEAD SO THAT A LEGAL TOUR IS MAINTAINED

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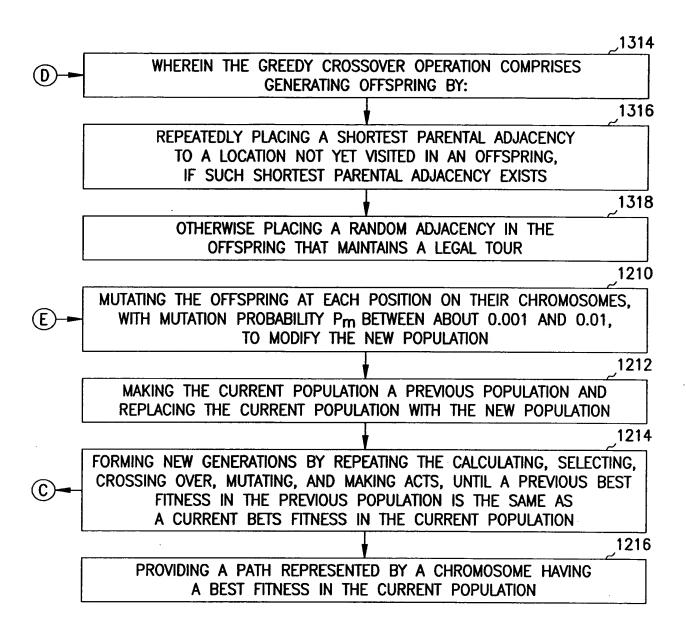


FIG. 13B

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1400

1202

RANDOMLY GENERATING AN INITIAL POPULATION OF CHROMOSOMES TO BE A CURRENT POPULATION. EACH CHROMOSOME HOLDING A PREDETERMINED NUMBER OF INTEGERS WITH ONE INTEGER AT EACH POSITION IN THE CHROMOSOME, EACH INTEGER REPRESENTING ONE LOCATION OF A SET OF LOCATIONS

CALCULATING A FITNESS FOR EACH CHROMOSOME IN THE CURRENT POPULATION, THE FITNESS MEASURING DISTANCE AND TIME SIMULTANEOUSLY

1206

1204

SELECTING ONE OR MORE PAIRS OF PARENT CHROMOSOMES FROM THE CURRENT POPULATION BASED ON THEIR FITNESS TO GENERATE THE NEW POPULATION

WHEREIN SELECTING THE PAIRS OF PARENT CHROMOSOMES FROM THE CURRENT POPULATION BASED ON THEIR FITNESS IS CARRIED OUT BY IMPLEMENTING A CHC SELECTION OPERATION

1404

1402

WHEREIN THE CHC SELECTION OPERATION COMPRISES:

1406

PLACING THE PAIRS OF PARENT CHROMOSOMES IN THE NEW POPULATION

1408

MERGING THE NEW POPULATION WITH THE CURRENT POPULATION BASED ON FITNESS

1410

UPON DETERMINING PREMATURE CONVERGENCE, RETAINING A NUMBER OF THE CURRENT POPULATION BASED ON FITNESS AND REPLACING THE REST OF THE CURRENT POPULATION WITH RANDOMLY GENERATED CHROMOSOMES

**FIG.** 14A

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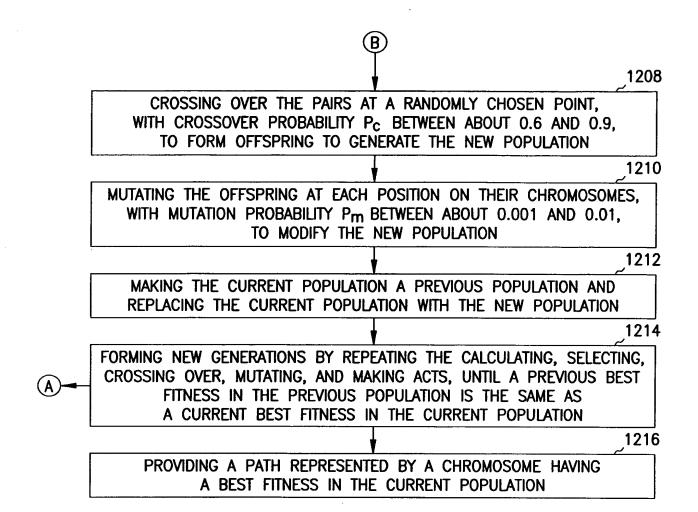


FIG. 14B

CLASS SUBCLASS

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1500 1502 **DETERMINING CURRENT ORDERS** 1504 DETERMINING A SET OF LOCATIONS TO VISIT WHICH COMPRISES LOCATIONS OF SUPPLIERS WITH PRODUCTS AVAILABLE FOR THE CURRENT ORDERS 1506 DETERMINING A STARTING LOCATION IN THE SET OF LOCATIONS 1508 DETERMINING A DISTRIBUTION CENTER PROXIMATE TO CUSTOMER LOCATIONS, THE CUSTOMER LOCATIONS BEING DELIVERY LOCATIONS FOR EACH CUSTOMER WHO PLACED ONE OF THE CURRENT ORDERS 1510 APPLYING A GENETIC ALGORITHM TO FIND A FIRST ROUTE STARTING AT THE STARTING LOCATIONS, ENDING AT THE DISTRIBUTION CENTER, AND VISITING EACH LOCATION IN THE SET OF LOCATIONS, WHILE MINIMIZING DISTANCE AND TIME 1512 PROVIDING THE FIRST ROUTE ON THE OUTPUT DEVICE 1514 STORING ANY UNDELIVERED PRODUCTS IN A BUFFER ON THE STORAGE DEVICE TO BE INCLUDED IN THE CURRENT ORDERS AND REMOVING THE ORDERS THAT THE FIRST ROUTE WILL FILL FROM THE CURRENT ORDERS

FIG. 15

FIG. 16

PROVIDING THE SECOND ROUTE ON THE OUTPUT DEVICE

STORING ANY UNDELIVERED PRODUCTS IN A BUFFER ON THE STORAGE DEVICE TO BE INCLUDED IN THE CURRENT ORDERS AND REMOVING THE ORDERS THAT THE FIRST ROUTE WILL FILL FROM THE CURRENT ORDERS

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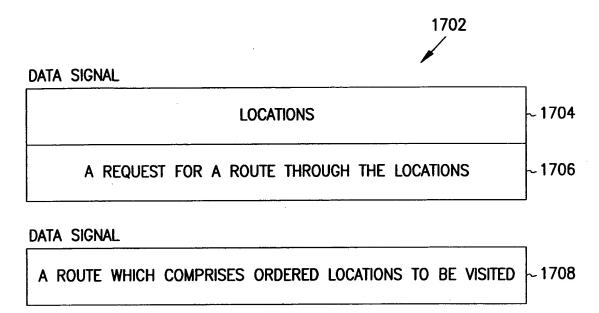


FIG. 17

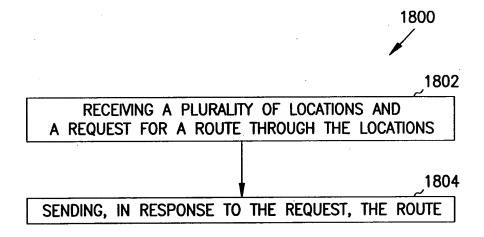


FIG. 18

TITLE: METHODS FOR SOLVING THE TRAVELING SALESMAN PROBLEM INVENTORS NAME: Ravindra K. Shetty DOCKET NO.: 256.098US1



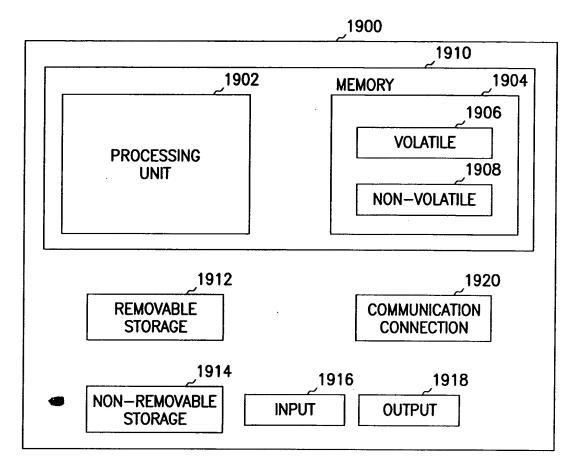


FIG. 19